

On the shoulders of giants...

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In a letter dated February 5, 1676 (dated 1675 using the Julian calendar), Sir Isaac Newton opined to Robert Hooke, "If I have seen further [than you and Descartes], it is by standing on the shoulders of giants."¹ That comment is frequently cited by physicians and surgeons who wish to recognize the debt owed to our predecessors whose efforts have brought us to our present state of enlightenment and understanding of the pathogenesis, diagnosis, and treatment of surgical disease. Many "surgical greats" were available for selection as the "surgical giants" for this supplement of the *Journal of Trauma and Acute Care Surgery*. The four selected "giants," whose contributions have had major influence on the organization and delivery of combat casualty care, were involved in wars of the early and mid-19th century (William Beaumont and Jonathan Letterman, respectively) and the two world wars of the 20th century (George Crile, World War I, and Edward D. Churchill, World War II) (Fig. 1). Each of the four was an experienced clinical surgeon of his time, and each appreciated the importance of scientific study to advance surgical care and improve patient outcomes.

WILLIAM BEAUMONT

William Beaumont, born in 1785, became a medical apprentice in 1810 and, in June 1812, was licensed to practice medicine by the Third Medical Society of Vermont. Three months later, he joined the Army as an assistant surgeon.² Beaumont described his experience as regimental surgeon caring for casualties generated by the explosion of an ammunition dump during the Battle of York (Toronto) in the spring of 1813. "Wading in Blood ... their wounds were of the worst kind ... I cut and slashed for 48 hours, without food or sleep."³

After the war, Beaumont, with a fellow Army surgeon, began a practice of "physic and surgery" in Plattsburgh, New York. When a post became available in the Army Medical Corps, Beaumont applied for a position and, in 1820, was accepted and assigned to the fort on Mackinac Island. His reentrance on active duty was facilitated by Surgeon General Joseph Lovell, with whom Beaumont had become close friends when they were assigned to the Army Hospital in Oswego, New York, during the War of 1812.² Shortly after arrival in Michigan, Beaumont requested and received from Lovell permission to engage in private practice, which allowed him to care for Alexis St. Martin, who in 1822 sustained a shotgun wound to his abdomen. St. Martin survived with a gastrocutaneous fistula, which enabled Beaumont to observe the response of St. Martin's stomach and gastric mucosa to a variety of stimuli.

Beaumont closely followed St. Martin, sending agents to bring him back when St. Martin tired of the studies and "escaped" from Beaumont and getting Lovell to authorize and fund a position for St. Martin while studies were conducted. Between 1825 and 1833, Beaumont performed 238 experiments on St. Martin and meticulously recorded all his observations. In the course of those studies, Beaumont collaborated with Robley Dunglison, professor of medicine at the University of Virginia; Benjamin Silliman, professor of chemistry and natural history at Yale; and Jons Jacob Berzelius, professor of chemistry in Sweden.² In essence, Beaumont was the principal investigator of what was arguably the world's first multidisciplinary, multi-institutional, integrated clinical/laboratory

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Figure 1. Four selected “giants” of military surgery whose works improved care and increased survival of combat casualties.

surgical research program.⁴ The results of those studies published by Beaumont in 1833 in “Experiments and Observations on the Gastric Juice and the Physiology of Digestion” established him as America’s first surgeon-scientist and gives the US Army primacy in the conduct of integrated surgical research in the United States.²

JONATHAN LETTERMAN

Jonathan Letterman, son of a surgeon and older brother of another surgeon, was born in 1824, graduated from Jefferson College in 1845 and Jefferson Medical College in 1849. Later in 1849, he passed the examination of the Army Medical Board and was appointed assistant surgeon in the Army Medical Department.⁵ Before the Civil War, Letterman provided surgical care for casualties in a number of military campaigns against Indian tribes in Florida, New Mexico, and California.⁶

Letterman was assigned to the Army of the Potomac in November 1861 and, in May 1862, was designated medical director of the Department of West Virginia. He was promoted to full surgeon and given the rank of major in June of 1862 and was then designated medical director of the Army of the Potomac by Surgeon General William A. Hammond. He immediately placed emphasis on efficient medical supply logistics, the enforcement of sanitary measures, and the prompt removal of the sick and wounded from the battlefield. Letterman developed a system to transport the injured (ultimately used by all Union Armies) in which each regiment was supported by three ambulances, each with two privates and a driver, and one transport cart with a driver.⁷ Drivers of the ambulances were required to complete a course of training designed by Letterman to increase their level of commitment and effectiveness.⁵ The ambulance system met a previously unfilled

need but was of limited capacity and often challenged by the number of casualties requiring transport.⁸

Letterman revised the staffing of field hospitals at the division level by moving the surgeons from the regimental level to the division level. Each surgeon was tested and assigned to duty as related to their skill level which, in effect, further extended the reorganization of the medical department instituted by Hammond to the regimental level. Letterman’s policy of professional privileging based on specialized skills and documented experience, such that only the three physicians in each division with the most extensive surgical experience were permitted to perform surgical operations, was unprecedented. The surgical historian, Ira Rutkow, termed Letterman’s surgical credentialing on the basis of expertise “one of the most momentous medical reforms to come out of the Civil War.”⁹

In recognition of the importance of casualty triage, Letterman established three echelons of treatment facilities.^{5,10} One physician from each regiment was assigned to a dressing station, usually on the battlefield, to provide first aid and apply tourniquets and the initial wound dressing. Other physicians were located at the Division Level Field Hospital, usually in a home or barn close to the battlefield where additional treatment and emergency surgery were provided. In addition to the three designated surgeons, one medical officer was delegated to maintain the records of every admission, and another was delegated to provide shelter, bedding, food, and water as well as organize the kitchen. Other physicians functioned as wound dressers.⁷ More complex and long-term care was then provided at the third echelon “large hospitals” remote from the battlefield.¹⁰

Along the way, Letterman made the medical logistics system more efficient by reducing the number of medicines and materials to be carried, thereby decreasing the number of wagons used to transport them by half.⁵ He increased the accountability of the medical department by means of scheduled medical inspections and compiling the detailed reports of the inspectors. His efforts to rationalize and organize combat casualty care during the Civil War earned him the title of “Father of Battlefield Medicine” and the honor of having the Army hospital at the Presidio in San Francisco named the Letterman Army Hospital.

GEORGE WASHINGTON CRILE

George Washington Crile, born November 11, 1864, received a BA degree from Northwestern Ohio Normal School in 1884 and, in 1887, his MD degree with highest honors from Wooster Medical College (later absorbed by the Western Reserve University School of Medicine).^{11,12} Following completion of his internship at the University Hospital in Cleveland under the direction of Dr. Frank C. Weed, he joined Weed and a third surgeon to build a practice in surgery. Throughout those years, Crile maintained his principal investigative interest in the study of shock. During the 1890s, Crile visited Billroth in Vienna and Horsley and Sherrington in London.^{12,13} The trip reinforced his interest in shock research and the role of the nervous system in the pathogenesis of shock. In 1899, his first book, *An Experimental Research Into Surgical Shock*,

was published, reporting studies for which he had received the Cartwright Prize awarded by Columbia University in 1897.¹²

In 1898, Crile was made a member of the Medical Reserve Corps and served in Puerto Rico during the Spanish-American War.¹³ His experiences reinforced his interest in shock as a surgical problem. In 1903, he developed a pneumatic rubber suit to decrease postural hypotension in neuro-surgical patients, which is recognized as an antecedent of the G-suit used by pilots in World War II to prevent high gravity force blackouts.¹² In 1906, he performed the first successful transfusion of blood between two people in the United States.¹⁴ In World War I, Crile again entered active duty as a major. General J.M. T. Finney named Crile the director of the central laboratory for the AEF, a laboratory where determinations could be performed to support the clinical studies of casualties.⁸ Crile's studies and those of Walter B. Cannon at the Central Laboratory advanced the understanding of shock as a problem in combat casualties.

Following his return to civilian life, Crile and three other surgeons developed a "group" practice of surgery and, in 1921, founded the Cleveland Clinic.¹⁵ At the clinic, Crile perfected thyroidectomy for the treatment of multinodular goiters, performed the first radical dissection for laryngeal and other cancers of the neck, and developed "balanced" anesthesia to minimize what he termed "subjective" shock as an operative complication.¹²

In 1912, Dr. Crile was part of the group that founded the American College of Surgeons, and in 1913,¹⁴ he was elected to honorary fellowship in the Royal College of Surgeons of England.¹² After World War I, Crile was appointed a brigadier general in the Medical Reserve Corps. He received the Distinguished Service Medal for his service in devising new methods of treatment to prevent infection and surgical shock and was made an honorary consultant to the Medical Department of the US Navy in World War II.¹⁴ In World War II, he was further honored by having a US Liberty Ship named SS George Crile. He was also honored by the naming of the lunar crater Crile.¹³

EDWARD D. CHURCHILL

Edward D. Churchill, born in 1895, attended Northwestern University, from which he received a BS degree in 1916 and an MA degree in 1917, and graduated cum laude from Harvard Medical School in 1920.¹⁶ Following internship and residency at the Massachusetts General Hospital (MGH), he remained there as an associate surgeon. As the Moseley Traveling Fellow, he studied in European centers for 2 years and returned to the MGH in 1927. In 1928, he founded the Harvard Surgical Service at the Boston City Hospital where he performed the first pericardectomy in the United States, collaborated with Oliver Cope to describe the Churchill-Cope reflex, and characterized various forms of pulmonary embolism, differentiating the pulmonary response to multiple small emboli from that to a single massive pulmonary embolism. In 1930, he returned to the MGH as the John Homans professor of surgery. He developed the use of lobectomy as treatment for lung disease including tuberculosis and, with Oliver Cope, perfected the surgical treatment for parathyroid disease.¹⁶

In World War II, Churchill volunteered for active duty in the US Army and was selected to be the chief consultant in surgery for the North African Theater of Operations and, later, the Mediterranean Theater of Operations.¹⁷ In that capacity, he promoted the use of whole blood for casualty resuscitation and established regional blood banks. He routinely visited treatment facilities within that command and emphasized adherence to treatment procedures and policies, which he established as the means to standardize care and achieve best outcomes.^{18,19} He championed meticulous debridement of wounds with delayed primary closure, which reduced the inappropriate reliance on sulfonamides as a substitute for surgery.¹⁸ He also developed a plan of casualty evacuation from the point of injury to the communication zone, which involved the use of aircraft and ensured continuity of care and increased survival.²⁰ He used the surgical specialty auxiliary groups to meet anticipated casualty needs generated by planned military action and evaluated the experience and capability of each surgeon before making duty assignments within the theater.^{18,19}

Of perhaps greatest importance was the role he played in the establishment of the Board for the Study of the Severely Wounded in September 1944.²¹ That multidisciplinary board was commanded by Henry K. Beecher, whom Churchill had nominated to become the first academic full-time professor of anesthesia at the MGH and shared Churchill's interest in the resuscitation of the injured and the use of blood transfusions.²⁰ That multidisciplinary board studied the effect of injury and shock on organ function, evaluated the effectiveness of various fluids in casualty resuscitation (including hypertonic salt in one patient), studied the crush syndrome, related acute renal failure to the severity and duration of shock, and warned against "excessive" fluid infusion in patients with renal failure. The board's work during the 9 months of its existence maintained the US Army tradition of scientific study to improve the care of injured patients.⁸ Churchill considered the board to have made, for the first time, precise clinical and laboratory measurements on casualties, which defined the pathophysiological response to injury.

Collectively, the work of these four "giants" maintained and promoted excellence of clinical care, continually revised and modernized the organization and delivery of combat casualty care to leverage technologic developments and expansion of medical knowledge, and established the US Army as the pioneer and persistent proponent of scientific study to address the pathophysiological problems and improve the outcomes of military casualties. The authors of the presentations in this supplement, by standing on the shoulders of these giants, have seen further and generated this information that has and will improve our treatment and the outcomes of those injured in combat.

DISCLOSURE

The authors declare no conflicts of interest.

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